Before the
Federal Communications Commission
Washington DC 20554

In the Matter of		
Amendment of Part 101 of the Commission's Rules to Increase Spectrum Use Through More Flexible Antenna Rules for the 10.7-11.7 GHz Band		RM-11043

COMMENTS OF ALCATEL

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August 23, 2004

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Amendment of Part 101 of the Commission's Rules to Increase Spectrum Use Through More Flexible Antenna Rules for the 10.7-11.7 GHz Band	|	RM-11043

COMMENTS OF ALCATEL

Alcatel respectfully submits the following comments in support of the Petition for Rulemaking (Petition) filed by FiberTower, Inc. in the above-captioned proceeding.[1] Alcatel manufactures communications equipment, including microwave radio products, and provides communications solutions to a wide range of commercial and government users.

I. Summary

Alcatel emphasizes that the availability of service for terrestrial fixed services depends on providing a system design that matches the requirements of each user. The Petitioner's proposed changes to Part 101 of the Commission's Rules, to permit the use of two-foot antennas in the 10.7-11.7 GHz (11 GHz) band, provides a viable optional alternative for applications that need antennas smaller than the current minimum four-foot antennas presently required to meet Category A and Category B specifications.[2] Therefore, Alcatel supports this Petition for the use of two-foot antennas in the 11 GHz band.

II. Discussion

Alcatel agrees with Petitioner that smaller antennas will increase utilization of the 11 GHz band by allowing links to be constructed on space- and weight-limited facilities. In addition,

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[1] *See* Public Notice, Report No. 2666, RM-11043 (released July 23, 2004).
[2] 47 C.F.R. Sec. 101.115(b).

smaller antennas will reduce the costs for users, and easier installation will speed up the deployment of new wireless links and associated services.

Results of some simplified interference path calculations show that the optional alternative Category A antenna ("New A") is comparable to production models of four-foot antennas having a gain of 40.4 dBi and meeting current Category A specifications for off-axis radiation suppression.[3] Therefore, deployment of the New A antenna is expected to have minimal impact on other users of the 11 GHz band because the off-axis gain performance of the New A antenna is comparable to current Category A antennas.

Because of lower rainfall attenuation, the 11 GHz band is well suited as an alternative to the 18 GHz band. Even with smaller antennas, the useful transmission range at 11 GHz will exceed that of the typical 18 GHz link, offering a solution for rain-limited applications in the 18 GHz band.

As the Petitioner noted, the Commission recently permitted two-foot antennas in the 10.55-10.68 GHz band.[4] Alcatel believes it is equally appropriate for the Commission to consider favorably the use of two-foot antennas in the 11 GHz band.

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[3] See attached "White Paper Report on Proposed Changes to Small Antenna Standards in the 11 GHz Band" prepared for Alcatel, N.A., Rev. 1, dated August 23, 2004. Please note that the data presented in the tables reflect calculations based on a preliminary value of 34.0 dBi for the minimum gain of an optional alternative Category A antenna. The Petition specifies a minimum gain of 33.5 dBi. The text of the report correctly states the results of the study and the conclusions using the 33.5 dBi value. Alcatel will file a revised report with corrected tables.

[4] See Petition of FiberTower at 1 n.1.

III. Conclusion

Alcatel strongly supports the Petition for amending Section 101.115(b) to accommodate the use of two-foot antennas in the 11 GHz band because of the benefits noted above: better utilization of the spectrum, easier installation, and cost savings for users of this band.

Respectfully submitted,

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August 23, 2004

White Paper Report

on

Proposed Changes to Small Antenna Standards

in the

11 GHz Band

Prepared by

D. L. Gross

for

Alcatel N.A.

Rev. 0 June 24, 2004
Rev. 1 August 23, 2004

Comparison Path Studies
for
Small Antenna Standard in 11 GHz Band

BACKGROUND:

FiberTower, Inc. has filed a petition for rulemaking with the FCC to allow the use of 2-foot antennas in the 11 GHz band. This white paper report presents the results of comparison path studies for determining the impact of the proposed, alternate small antenna standards in the 10.7-11.7 GHz (11 GHz) band.

SUMMARY OF RESULTS:

The off-axis gain characteristics of the proposed, alternate Category A (New A) antenna standard in the 11 GHz band are comparable to the current Category A requirement for radiation suppression because of the reduced main beam gain.

> Off-Axis Gain (dBi) = Main Beam Gain (dBi) – Radiation Suppression* (dB)
> [*as specified in antenna standards table, FCC Rules §101.115]

As a result, calculated interference levels using the New A antenna will be lower at angles between 10-30 degrees and 100-180 degrees off-axis compared to an actual, i.e., production model, Category A antenna having a main beam gain of 40.4 dBi and only 0.1 dB higher between 5-10 degrees and 30-100 degrees. (See graph titled "Off-Axis Gain Comparison" on page 13 of this report.)

Therefore, the separation between microwave paths with different combinations of antennas (i.e., current Category A and New A) is more dependent on the respective transmitter power of each path than on the antenna performance or off-axis gain.

The advantages of smaller, 2-foot, antennas (e.g., size, cost, ease of installation) would facilitate the installation of more microwave paths in metropolitan areas using lower power transmitters on shorter paths, thereby resulting in a greater utilization of the 11 GHz microwave spectrum.

METHODOLOGY:

This white paper presents the results of twenty-two (22) different combinations of path length, antenna model, and transmitter power that were used to evaluate the impact of the proposed changes for small antenna standards in the 11 GHz band. The same interference objective of -103 dBm was used in all cases, based on a -69 dBm receiver threshold for 3 DS-3 radios and a T/I ratio of 34 dB. A total of 528 simplified interference calculations were made for these comparison path studies.

Four different parallel path length configurations were used for this study:
10 mi. – 10 mi., 5 mi. – 10 mi., 2 mi. – 10 mi., and 2 mi. – 2 mi.

The off-axis angle, θ_1, at Site A (same angle at Site D) was adjusted in 10-degree increments from 10 degrees to 60 degrees. The corresponding off-axis angle, θ_2, at Site B (same angle at Site C) was then calculated for each increment along with the path distance and free space loss between Sites A and D and Sites B and C. (Refer to Figure 1, Path Study Configuration.) Interference levels were then calculated and compiled. (See page 8 for a Comparison Chart sample with the results of one path study.)

An overview table of the 22 path studies lists the minimum off-axis angle that could be used for each path configuration and the resultant separation distance between the parallel paths. (Refer to page 15.) Conclusions stated in this report are based on this data and the antenna off-axis gain tables and graphs presented on pages 11-13.

OBSERVATIONS:

The proposed, alternate Category A (New A) antenna standard is basically the same as the current Category B antenna standard except for an improvement of 19 dB in radiation suppression between 100 –180 degrees off-axis from the main beam and 2 dB less radiation suppression between 5-10 degrees off-axis.

The proposed, alternate Category B (new B) antenna pattern is basically the same as the current Category B antenna pattern except for a 4 dB improvement between 100-140 degrees off-axis and a 9 dB improvement between 140-180 degrees off-axis. The new B pattern proposes a 3 dB relaxation of radiation suppression between 5-10 degrees off-axis.

The calculation of interference levels into foreign stations (i.e., any station other than the desired receive station) takes into account the off-axis gain of the respective transmit and receive antennas. (Refer to Figures 1. and 2., Path Study Configurations.)

$I_{CB} = I_{BC}$* when P_C is the same as P_B (reference equations 2 and 8, respectively) and $I_{DA} = I_{AD}$ when P_D is the same as P_A (reference equations 6 and 4, respectively). In each pair of referenced equations all of the terms are equivalent except for the transmitter powers. Therefore, when the transmitter powers are the same (assuming similar rack configurations), the calculated level of interference will be the same in both directions, i.e. I_{CB} (Site C to Site B) will equal I_{BC} (Site B to Site C). (Refer to Figure 3., Interference Path Calculations diagram on page 14.)

**** Key to terms used in the paragraph above and in the following sections of this report:***

For example:

$$C_{AB} = P_A - L_A + G_A - FSL_{AB} + G_B - L_B \qquad \text{Eq. 1}$$

$$I_{CB} = P_C - L_C + G_{C\theta 2} - FSL_{CB} + G_{B\theta 2} - L_B \qquad \text{Eq. 2}$$

where:

C_{AB} = carrier or signal level on the desired path from Site A to Site B in dBm,
P_A = transmitter power level at Site A in dBm,
L_A = line losses at Site A in dB,
G_A = main beam gain of the antenna at Site A in dBi,
FSL_{AB} = free space loss for path between Site A and Site B in dB,
G_B = main beam gain of the antenna at Site B in dBi,
L_B = line losses at Site B in dB,
and
I_{CB} = interference signal level from Site C received at Site B in dBm,
$G_{C\theta 2}$ = off-axis gain (in dBi) of the antenna at Site C at the off-axis angle of θ_2,
$G_{B\theta 2}$ = off-axis gain (in dBi) of the antenna at Site B at the off-axis angle of θ_2.

CONCLUSIONS:

The off-axis gain characteristics of the proposed, alternate Category A (New A) antenna in the 11 GHz band are comparable to the current Category A requirement because of the reduced main beam gain.

> Off-Axis Gain (dBi) = Main Beam Gain (dBi) – Radiation Suppression (dB)
> [as specified in antenna standards table, FCC Rules §101.115]

As a result, calculated interference levels using the New A antenna will be lower at angles between 10-30 degrees and 100-180 degrees off-axis compared to an actual, i.e., production model, Category A antenna (having a main beam gain of 40.4 dBi) and only 0.1 dB higher between 5-10 degrees and 30-100 degrees.

Short paths with lower power transmitters will be disadvantaged with respect to longer paths using standard power; therefore, larger discrimination angles are needed to meet the threshold interference requirement. Because of the comparable off-axis gain characteristics of the New A standards with respect to the current standards, the impact on path separation is about the same for both antenna standards.

Many 11 GHz links have a low number of RF channels in operation; therefore, interference conflicts can also be prevented by selecting alternate channels to avoid co-channel frequency operation.

The New A antenna is not suitable for one end of a 10-mile path because of insufficient fade margin to combat predicted rainfall outage in the Dallas area and equivalent rainfall regions.

The use of the New A antenna at both ends of a 5-mile path would meet the minimum fade margin requirement for vertical polarization, but not for horizontal polarization in a rainfall region equivalent to that of Dallas, Texas.

Path Study Configuration (1 of 2)

Small Antenna Comparison
11 GHz Band

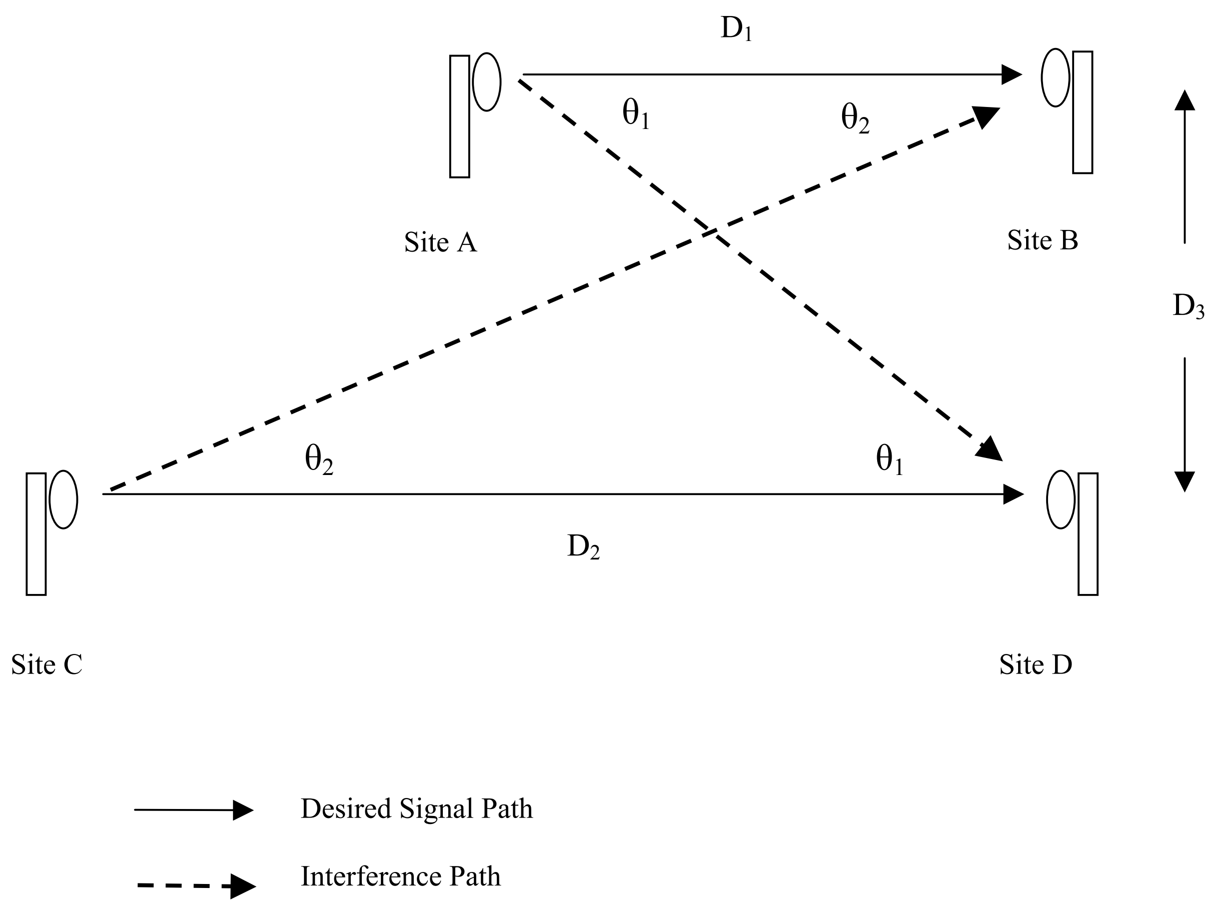


Figure 1. Path Study Configuration for I_{AD} and I_{CB}

$$C_{AB} = P_A - L_A + G_A - FSL_{AB} + G_B - L_B \quad \text{Eq. 1}$$

$$I_{CB} = P_C - L_C + G_{C\theta 2} - FSL_{CB} + G_{B\theta 2} - L_B \quad \text{Eq. 2}$$

$$C_{CD} = P_C - L_C + G_C - FSL_{CD} + G_D - L_D \quad \text{Eq. 3}$$

$$I_{AD} = P_A - L_A + G_{A\theta 1} - FSL_{AD} + G_{D\theta 1} - L_D \quad \text{Eq. 4}$$

Path Study Configuration (2 of 2)

Small Antenna Comparison
11 GHz Band

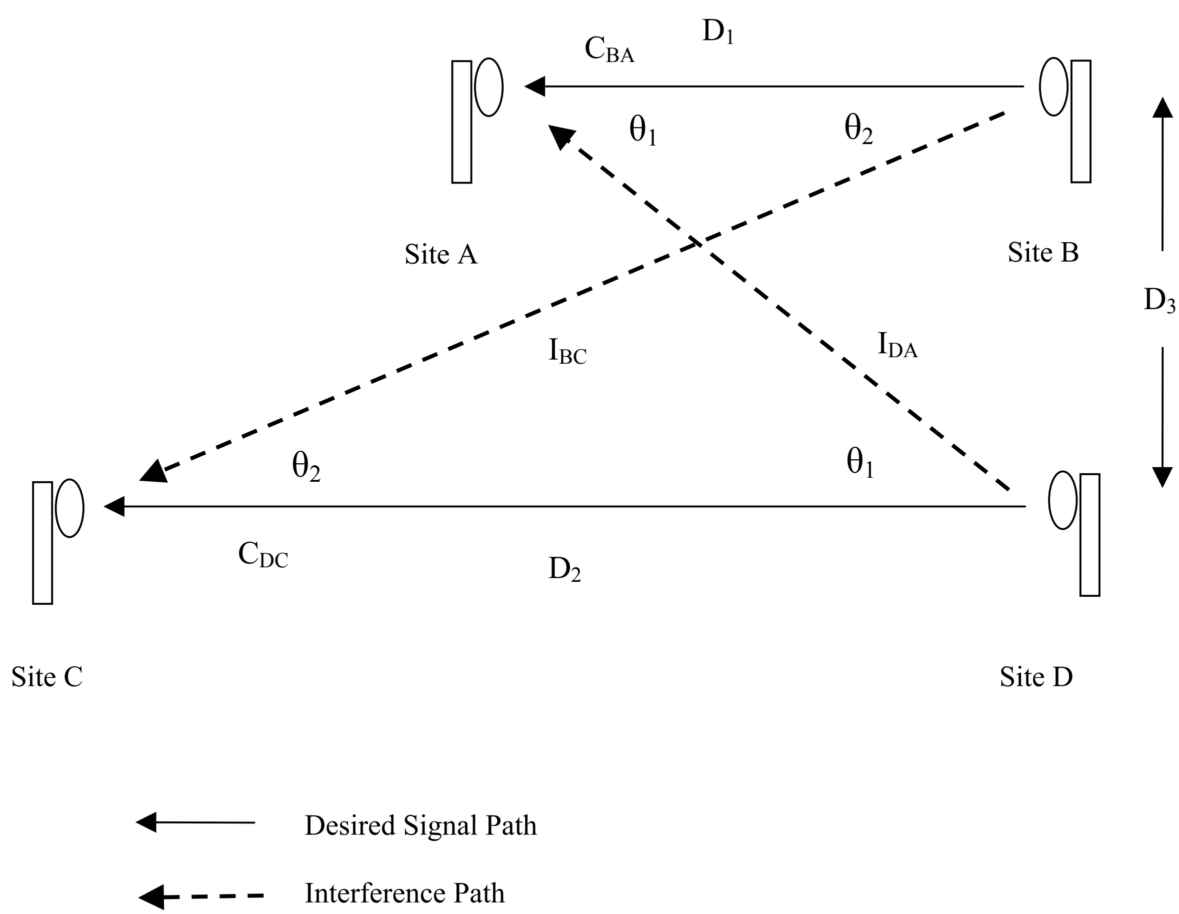


Figure 2 Path Study Configuration for I_{DA} and I_{BC}

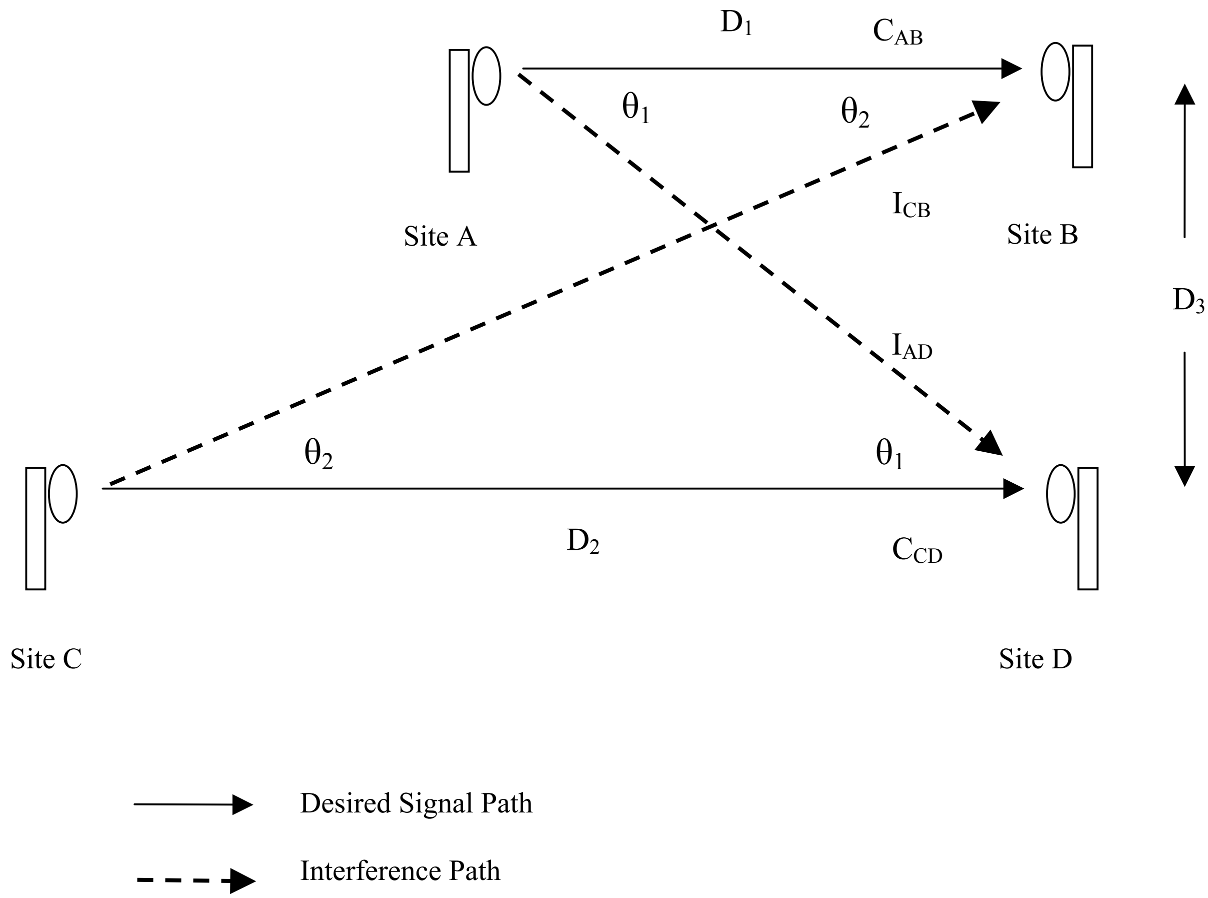
$$C_{BA} = P_B - L_B + G_B - FSL_{BA} + G_A - L_A \qquad \text{Eq. 5}$$

$$I_{DA} = P_D - L_D + G_{D\theta 1} - FSL_{DA} + G_{A\theta 1} - L_A \qquad \text{Eq. 6}$$

$$C_{DC} = P_D - L_D + G_D - FSL_{DC} + G_C - L_C \qquad \text{Eq. 7}$$

$$I_{BC} = P_B - L_B + G_{B\theta 2} - FSL_{BC} + G_{C\theta 2} - L_C \qquad \text{Eq. 8}$$

Small Antenna Comparison
11 GHz Band



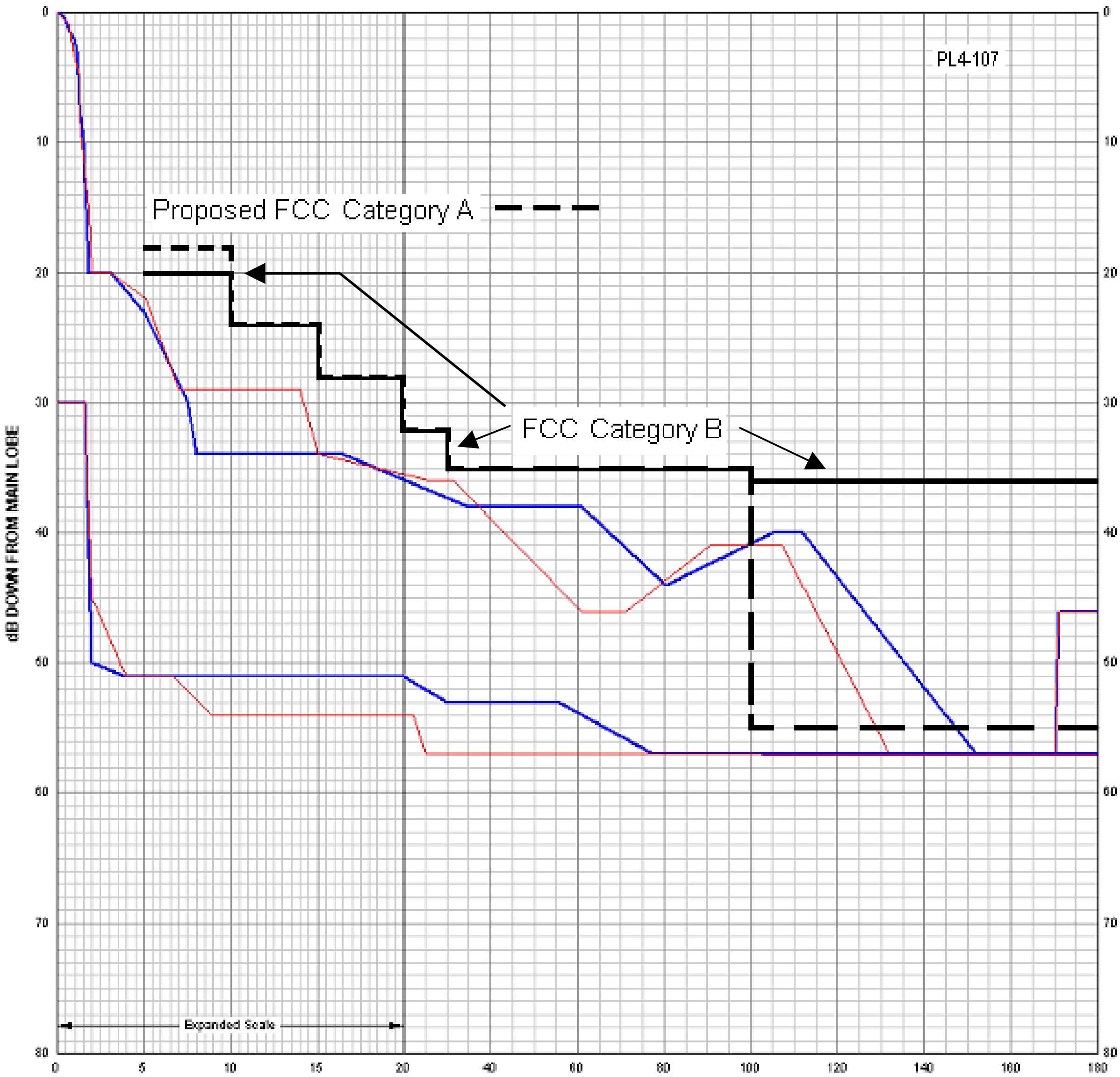
<u>Table of Off-Axis Angles</u>
<u>5 Mi. : 10 Mi. Path Configuration</u>

Off-Axis Angle
θ_1 : θ_2

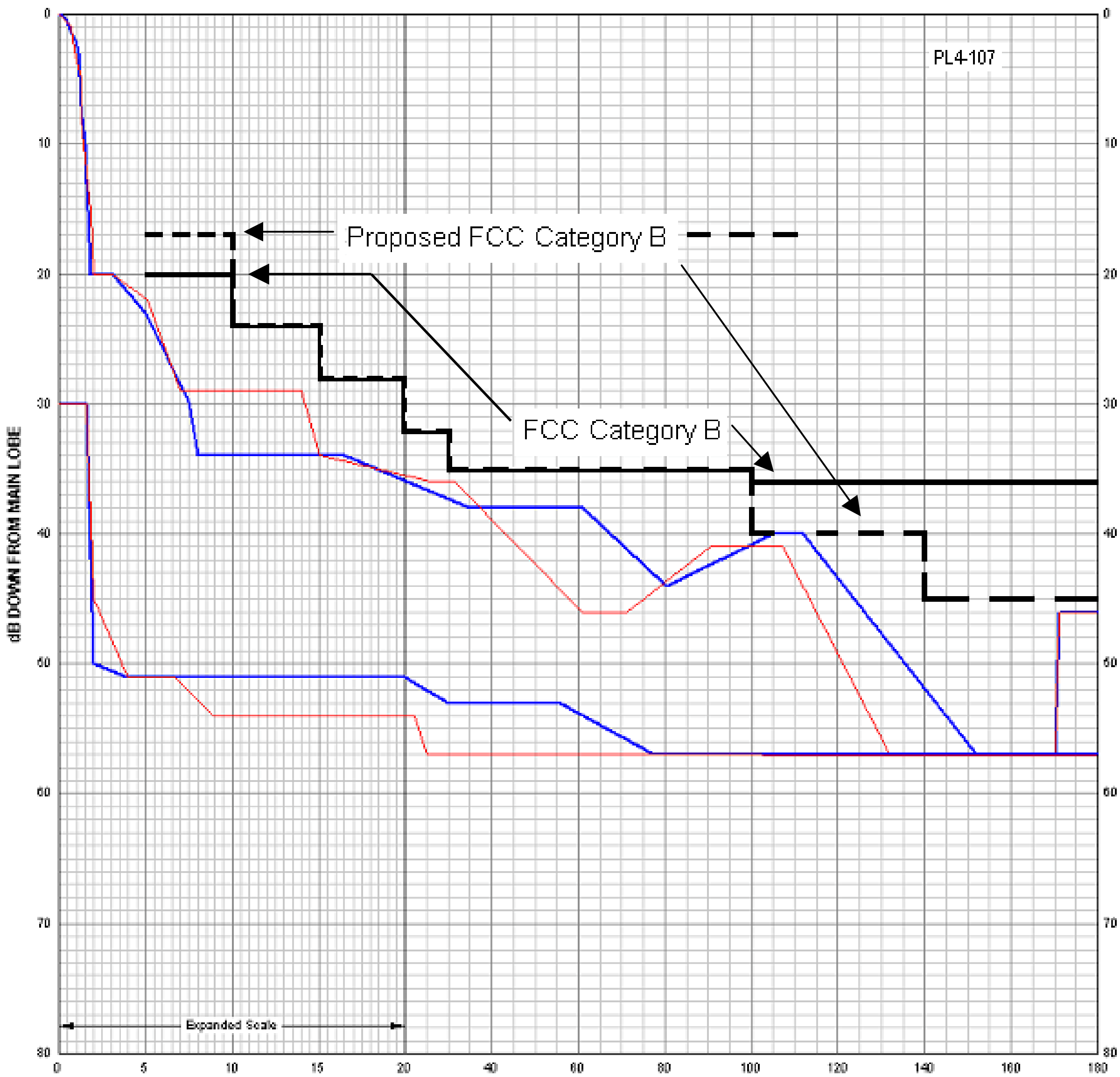
10° : 5.04°
20° : 10.3°
30° : 16.1°
40° : 22.8°
50° : 30.8°
60° : 40.9°

Case #	COMPARISON CHART FOR SMALL ANTENNAS IN 11 GHz BAND							
				SAMPLE				
		D1					**D2**	
		Length A-B in miles	Free Space Loss (dB)				Length C-D in miles	Free Space Loss (dB)
		2	123.6				10	137.6
	θ1			**D3**		**θ2**		
	Angle BAD, CDA (Deg)	Length AD, DA (Mi)	Free Space Loss (dB)	Separation B-D (Mi.)		Angle ABC, DCB (Deg)	Length BC, CB (Mi)	Free Space Loss (dB)
	10	2.0	123.7	0.4		2.02	10.0	137.6
	20	2.1	124.1	0.7		4.2	10.0	137.6
	30	2.3	124.9	1.2		6.6	10.1	137.6
	40	2.6	125.9	1.7		9.5	10.1	137.7
	50	3.1	127.4	2.4		13.4	10.3	137.8
	60	4.0	129.6	3.5		19.1	10.6	138.1
13	HP4 (AB) and HP6 (CD)							
	P_{TX} (dBm) >	15 : 27			15 : 27		Fade Margin in dB	
	C_{AB}	-33.8	Off-axis angle	C_{BA}	-33.8		35.2	
	I_{CB}	-70.2	2.02 : 10	I_{DA}	-84.3			
	I_{CB}	-84.2	4.2 : 20	I_{DA}	-96.7			
	I_{CB}	-90.7	6.6 : 30	I_{DA}	-103.5			
	I_{CB}	-96.3	9.5 : 40	I_{DA}	-106.5			
	I_{CB}	-98.4	13.4 : 50	I_{DA}	-111.0			
	I_{CB}	-107.1	19.1 : 60	I_{DA}	-119.2			
		for P_A, P_B = 15 and P_C, P_D = 27						
			Off-axis angle				Fade Margin in dB	
	C_{CD}	-28.6		C_{DC}	-28.6		40.4	
	I_{AD}	-96.3	10 : 2.02	I_{BC}	-82.2			
	I_{AD}	-108.7	20 : 4.2	I_{BC}	-96.2			
	I_{AD}	-115.5	30 : 6.6	I_{BC}	-102.7			
	I_{AD}	-118.5	40 : 9.5	I_{BC}	-108.3			
	I_{AD}	-123.0	50 : 13.4	I_{BC}	-110.4			
	I_{AD}	-131.2	60 : 19.1	I_{BC}	-119.1			

Andrew Model PL4-107 Microwave Dish Antenna Pattern
with
FCC Category B and Proposed Category A



Andrew Model PL4-107 Microwave Dish Antenna Pattern
with
FCC Category B and Proposed Category B



11 GHz Small Antenna Standards
Comparison of Off-Axis Gain

Off-axis angle	Current Category A Radiation Suppression (dB)	Off-axis Antenna Gain* (dBi)	EIRP w/+24 dBm (27 -3 dB)** dBm	New A Δ Gain (dB)
0°	0	**38**	+62	
5° - 10°	25	+13	+37	**3**
10° - 15°	29	+9	+33	**1**
15° - 20°	33	+5	+29	**1**
20° - 30°	36	+2	+26	**0**
30° - 100°	42	-4	+20	**3**
100° - 140°	55	-17	+7	**-4**
140° - 180°	55	-17	+7	**-4**

Off-axis angle	Proposed Category A Radiation Suppression (dB)	**Off-axis Antenna Gain "New A" (dBi)**	EIRP w/+24 dBm (27 - 3 dB)* dBm	EIRP w/+12 dBm (Short) (Link) dBm
0°	0	**34**	+58	+46
5° - 10°	18	**+16**	+40	+28
10° - 15°	24	**+10**	+34	+22
15° - 20°	28	**+6**	+30	+18
20° - 30°	32	**+2**	+26	+14
30° - 100°	35	**-1**	+23	+11
100° - 140°	55	**-21**	+3	-9
140° - 180°	55	**-21**	+3	-9

		P4-107	EIRP	**New A**
0°	0	**40.4**	+64.4	**Δ Gain**
	(Cat. A)	(dBi)	(dBm)	**(dB)**
5° - 10°	25	+15.4	+39.4	**0.6**
10° - 15°	29	+11.4	+35.4	**-1.4**
15° - 20°	33	+7.4	+31.4	**-1.4**
20° - 30°	36	+4.4	+28.4	**-2.4**
30° - 100°	42	-1.6	+22.4	**0.6**
100° - 140°	55	-14.6	+9.4	**-6.4**
140° - 180°	55	-14.6	+9.4	**-6.4**

		P6-107	EIRP	**New A**
0°	0	**44.0**	+68	**Δ Gain**
	(Cat. A)	(dBi)	(dBm)	**(dB)**
5° - 10°	25	+19	+43	**-3**
10° - 15°	29	+15	+39	**-5**
15° - 20°	33	+11	+35	**-5**
20° - 30°	36	+8	+32	**-6**
30° - 100°	42	+2	+26	**-3**
100° - 140°	55	-11	+13	**-10**
140° - 180°	55	-11	+13	**-10**

		HP4-107	EIRP	**New A**
0°	0	**40.4**	+64.4	**Δ Gain**
	Actual	(dBi)	(dBm)	**(dB)**
5° - 10°	25	+15.4	+39.4	**0.6**
10° - 15°	30	+10.4	+34.4	**-0.4**
15° - 20°	33	+7.4	+31.4	**-1.4**
20° - 30°	36	+4.4	+28.4	**-2.4**
30° - 55°	42	-1.6	+22.4	**0.6**
60° - 65°	45	-4.6	+19.4	**3.6**
70° - 75°	54	-13.6	+10.4	**12.6**
76° - 90°	57	-16.6	+7.4	**15.6**
95° - 180°	61	-20.6	+3.4	**-0.4**

		HP6-107	EIRP	**New A**
0°	0	**44.0**	+68	**Δ Gain**
	Actual	(dBi)	(dBm)	**(dB)**
5°	30	+14	+38	**2**
6° - 9°	32.5	+11.5	+35.5	**4.5**
9.5° - 15°	36	+8	+32	**2**
20° - 30°	42	+2	+26	**0**
50°	46	-2	+22	**1**
99°	69	-25	-1	**24**
102° - 180°	70	-26	-2	**5**

		HP8-107	EIRP	**New A**
0°	0	**46.4**	+70.4	**Δ Gain**
	Actual	(dBi)	(dBm)	**(dB)**
5°	30	+16.4	+40.4	**-0.4**
5.5° - 7°	31	+15.4	+39.4	**0.6**
7.5° - 9°	33	+13.4	+37.4	**2.6**
10.5°	37	+9.4	+33.4	**0.6**
15°	38	+8.4	+32.4	**-2.4**
25°	47	-0.6	+23.4	**2.6**
40°	48	-1.6	+22.4	**0.6**
60°	53	-6.6	+17.4	**5.6**
98°	71	-24.6	-0.6	**23.6**
100° - 180°	72	-25.6	-1.6	**4.6**

* Off-axis Gain = Main Beam Gain - Radiation Suppression

** EIRP = Ptx - Line Loss + Gant

** EIRP = +27 dBm - 3 dB + Gant

Maximum allowable EIRP = +55 dBW (+85 dBm)

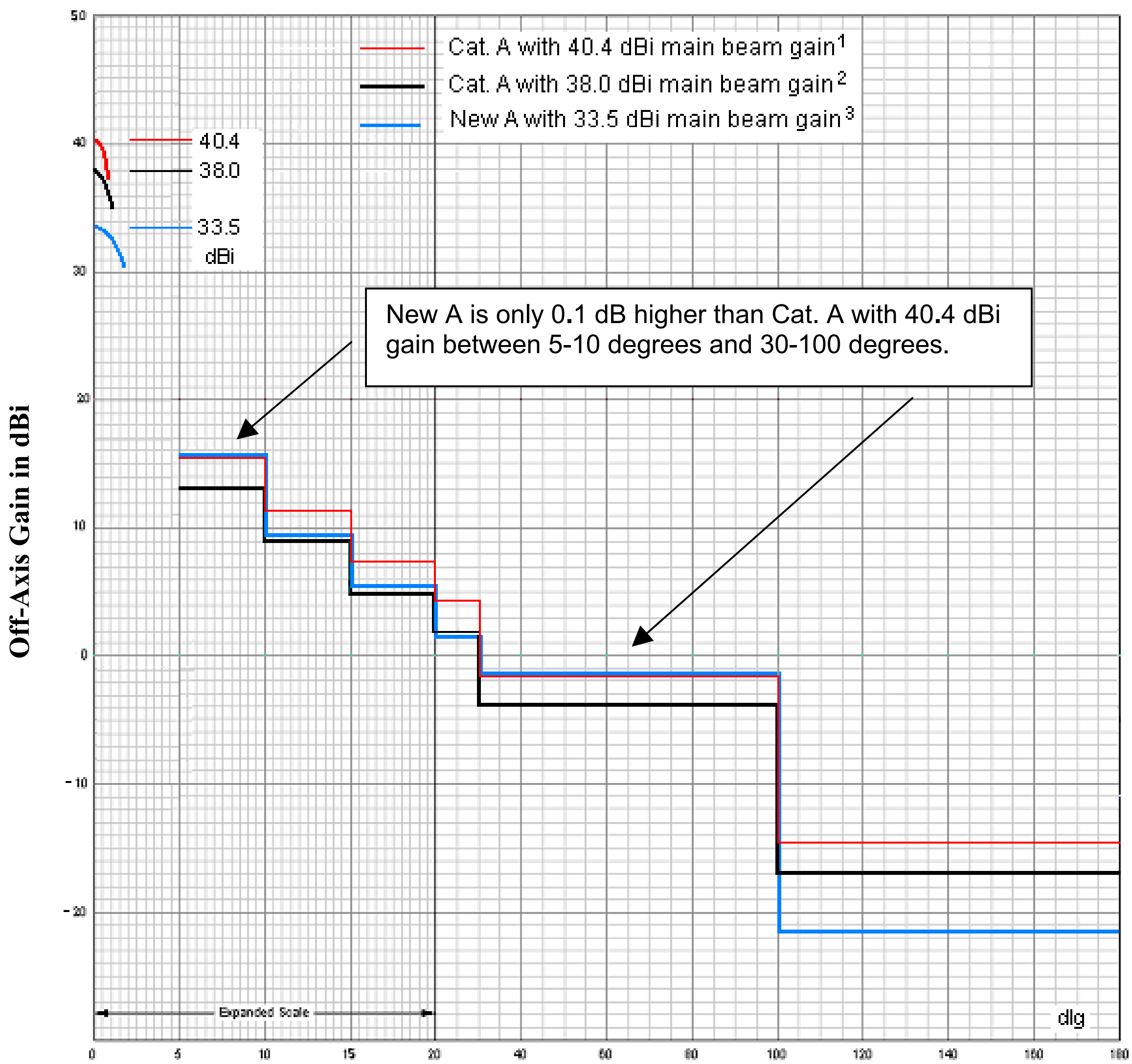
2-mile path EIRP Limit = 55-(40*LOG10(3.1/2)) = 47.4 dBW

or 77.4 dBm

dlg 06/11/04

Main Beam Antenna Gain (dBi)						Main Beam Antenna Gain (dBi)				Antenna Gain (dBi)	
	38		34		<< 0° >>		40.4		44.0		46.4
Standard A Current Off-Axis Suppression	Standard A Current Off-Axis Gain (dBi)	Standard A Proposed Off-Axis Suppression	Standard A Proposed Off-Axis Gain (dBi)		Off-Axis Angle	HP4-107 Actual Off-Axis Suppression	HP4-107 Actual Off-Axis Gain (dBi)	HP6-107 Actual Off-Axis Suppression	HP6-107 Actual Off-Axis Gain (dBi)	HP8-107 Actual Off-Axis Suppression	HP8-107 Actual Off-Axis Gain (dBi)
29	+9	24	+10		10°	30	+10.4	36	+8	35.7	+10.7
36	+2	32	+2		20°	36	+4.4	42	+2	45.5	+0.9
42	-4	35	-1		30°	42	-1.6	42	+2	47.5	-1.1
42	-4	35	-1		40°	42	-1.6	44	0	48	-1.6
42	-4	35	-1		50°	43	-2.6	46	-2	50.5	-4.1
42	-4	35	-1		60°	45	-4.6	50	-6	53	-6.6
29	+9	24	+10		**10.0°**	30	+10.4	36	+8	35.7	+10.7
36	+2	32	+2		**20.0°**	36	+4.4	42	+2	45.5	+0.9
42	-4	35	-1		**30.0°**	42	-1.6	42	+2	47.5	-1.1
42	-4	35	-1		**40.0°**	42	-1.6	44	0	48	-1.6
42	-4	35	-1		**50.0°**	43	-2.6	46	-2	50.5	-4.1
42	-4	35	-1		**60.0°**	45	-4.6	50	-6	53	-6.6

Off-Axis Gain Comparison
for
Category A and New Category A Antennas



Off-Axis Gain (dBi) = Main Beam Gain (dBi) – Radiation Suppression (dB)

[1] Actual production models for high-performance antennas have a gain of 40.4 dBi.
[2] Current FCC Cat. A for mw antennas specifies a minimum main beam gain of 38.0 dBi. [as specified in antenna standards table, FCC Rules §101.115]
[3] Proposed Cat.A for antennas with a minimum main beam gain of 33.5 dBi.

Interference Path Calculations

Small Antenna Comparison

11 GHz Band

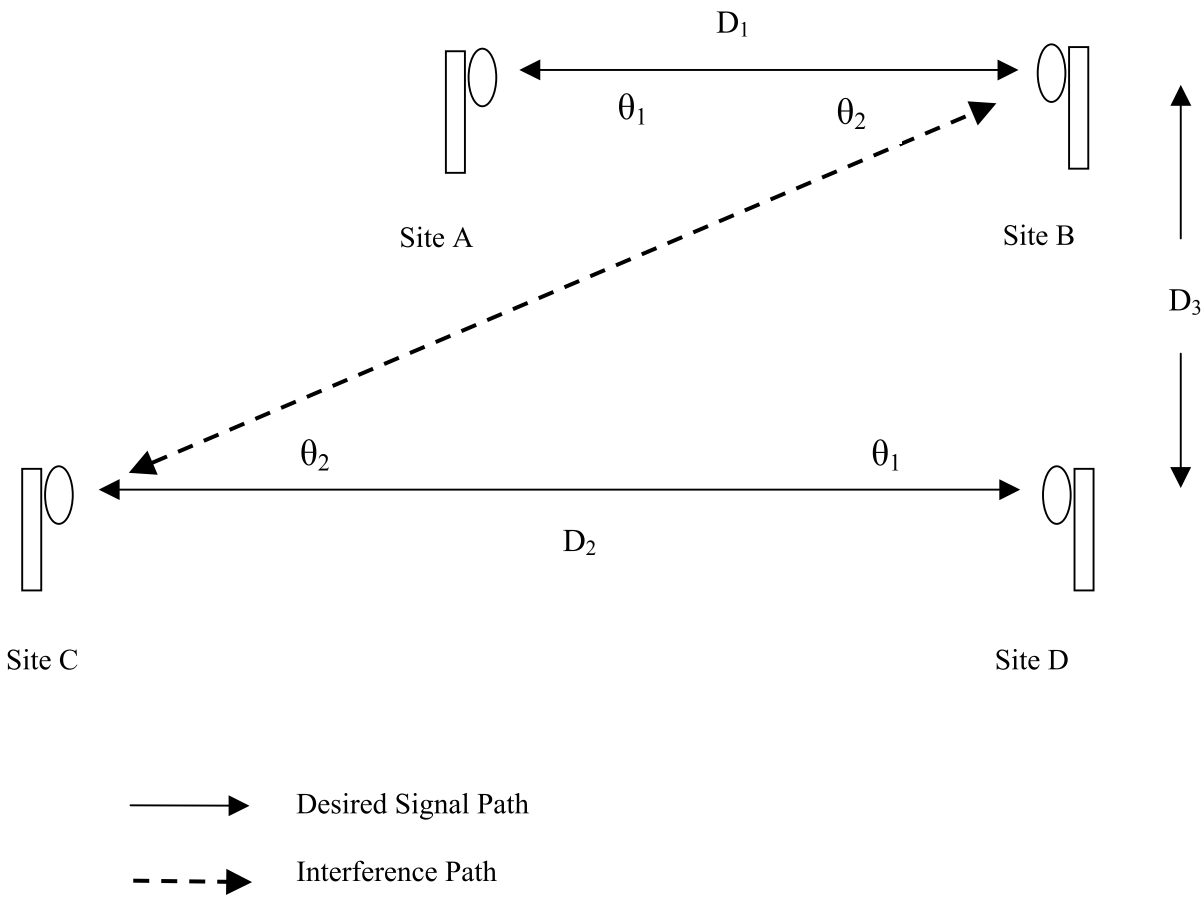


Figure 3. Interference Path Calculations for I_{CB} and I_{BC}

$$I_{CB} = P_C - L_C + G_{C\theta 2} - FSL_{CB} + G_{B\theta 2} - L_B \qquad \text{Eq. 2}$$

$$I_{BC} = P_B - L_B + G_{B\theta 2} - FSL_{BC} + G_{C\theta 2} - L_C \qquad \text{Eq. 8}$$

OVERVIEW OF SMALL ANTENNA PATH STUDIES

Case #							
	D1 = 10 mi.	(Min. F.M. = 35 - 40 dB)		**D2 = 10 mi.**	(Min. F.M. = 35 - 40 dB)		
	ANTENNA TYPE		**XTMR**	**FADE**	**θ_1, θ_2**	**D3**	**FOREIGN**
	Sites	Sites	**POWER**	**MARGIN**	Off-axis	Separation	**RSL**
	A - B	C - D	A-B : C-D	A-B : C-D	Angles	Distance	(dBm)
1	**HP6-HP6**	**HP6-HP6**	**27 : 27**	**40.4 : 40.4**	**16 : 16**	**2.9 mi.**	**-103.7**
2	**HP8-HP8**	**HP8-HP8**	**23 : 23**	**41.2 : 41.2**	**12.5:12.5**	**2.2 mi.**	**-103.2**
(3)	HP4-HP4	HP4-HP4	27 : 27	33.2 : 33.2	20 : 20.0	3.6 mi.	-108.3
(4)	New A-New A	HP4-HP4	27 : 27	20.4 : 33.2	15 : 15	2.7 mi.	-103.5
(5)	New A-New A	HP6-HP6	27 : 23	20.4 : 36.4	15 : 15	2.7 mi.	-102.9
(6)	HP6-New A	HP6-HP6	27 : 27	30.4 : 40.4	16 : 16	2.9 mi.	-103.7
(7)	HP8-New A	HP6-HP6	27 : 27	32.8 : 40.4	16 : 16	2.9 mi.	-103.4
	D1 = 5 mi.	(Min. F.M. = 24 - 28 dB)		**D2 = 10 mi.**	(Min. F.M. = 35 - 40 dB)		
	ANTENNA TYPE		**XTMR**	**FADE**	**θ_1, θ_2**	**D3**	**FOREIGN**
	Sites	Sites	**POWER**	**MARGIN**	Off-axis	Separation	**RSL**
	A - B	C - D	A-B : C-D	A-B : C-D	Angles	Distance	(dBm)
(8)	New A-New A	HP4-HP4	27 : 27	26.4 : 33.2	15.5 : 29	2.8	-103.5
9	New A-New A	HP6-HP6	27 : 23	26.4 : 36.4	15.5 : 29	2.8	-103.4
10	**HP4-HP4**	**HP6-HP6**	**23 : 27**	**35.2 : 40.4**	**16.1 : 30**	**2.9**	**-102.5**
(11)	HP4-New A	HP4-HP4	23 : 27	28.8 : 33.2	15.0 : 28.2	2.7	-103.1
12	HP4-New A	HP6-HP6	23 : 27	28.8 : 40.4	15 : 28.2	2.7	-102.9
	D1 = 2 mi.	(Min. F.M. = 15 dB)		**D2 = 10 mi.**	(Min. F.M. = 35 - 40 dB)		
	ANTENNA TYPE		**XTMR**	**FADE**	**θ_1, θ_2**	**D3**	**FOREIGN**
	Sites	Sites	**POWER**	**MARGIN**	Off-axis	Separation	**RSL**
	A - B	C - D	A-B : C-D	A-B : C-D	Angles	Distance	(dBm)
13	**HP4-HP4**	**HP6-HP6**	**15 : 27**	**35.2 : 40.4**	**16.5 : 56**	**3**	**-103.6**
14	HP4-HP4	HP6-HP6	15 : 23	35.2 : 36.4	13.9 : 51	2.5	-103.2
(15)	New A-New A	HP4-HP4	15 : 27	22.4 : 33.2	15 : 53.2	2.7	-103.5
(16)	New A-New A	HP4-HP4	23 : 27	30.4 : 33.2	15 : 53.2	2.7	-103.5
17	New A-New A	HP6-HP6	15 : 27	22.4 : 40.4	15 : 53.2	2.7	-102.9
18	New A-New A	HP6-HP6	15 : 23	22.4 : 36.4	10.2 : 42	1.8	-102.7
19	New A-New A	HP6-HP6	23 : 23	30.4 : 36.4	10.2 : 42	1.8	-102.7
	D1 = 2 mi.	(Min. F.M. = 15 dB)		**D2 = 2 mi.**	(Min. F.M. = 15 dB)		
	ANTENNA TYPE		**XTMR**	**FADE**	**θ_1, θ_2**	**D3**	**FOREIGN**
	Sites	Sites	**POWER**	**MARGIN**	Off-axis	Separation	**RSL**
	A - B	C - D	A-B : C-D	A-B : C-D	Angles	Distance	(dBm)
20	New A-New A	HP4-HP4	15 : 15	22.4 : 35.2	20.0 : 20	0.7	-108.7
21	New A-New A	New A-New A	15 : 15	22.4 : 22.4	15 : 15	0.5	-102.9
22	**HP4-HP4**	**HP4-HP4**	**15 : 15**	**35.2 : 35.2**	**20.0 : 20**	**0.7**	**-106.3**
Key							
#	**Bold # and font indicates control case study.**						
#	Regular font indicates viable path with New A antenna at one or more sites.						
(#)	Indicates case not meeting minimum fade margin requirement on one or both paths.						

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